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(21)Application number : 07-062824 (71)Applicant : NEC CORP

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(54) BUMP STRUCTURE, METHOD FOR FORMING BUMP AND CAPILLARY BEING EMPLOYED THEREIN

(57)Abstract:

PURPOSE: To obtain a bump for flip-chip mounting an electrode at fine pitch and method for forming the bump and a capillary being employed therein.

CONSTITUTION: The inventive bump is a double stage bump 7 comprising a nearly tubular first bump 4 of conductive material having bottom face secured onto an Al electrode 3 of a semiconductor element 1, and a second bump 5 of the same kind of conductive material as the first bump 4 having bottom face secured to the upper surface of the first bump 4. The method for forming the bump comprises a step for forming a metal ball at the tip of a wire passed through a hole made vertically to the edge 10 of a capillary 8 for forming a bump, a step for applying ultrasonic wave while pressing the metal ball against the electrode of the semiconductor element 1 at the tip of the capillary to bond the first tubular bump 4 to the electrode, a step for shifting the tip of the capillary 8 laterally and applying ultrasonic wave while pressing the tip of the capillary 8 against the electrode, and a step for cutting off a wire from the first tubular bump 4 and forming the second bump 5 on the first bump 4 similarly to the first bump 4.

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CLAIMS

[Claim(s)]
[Claim 1] Bump structure characterized by consisting of the 1st bump who consists of the electrical conducting material which the base fixed, and which is a cylindrical shape-like mostly on an electrode, the 1st bump whom the base fixed on this 1st bump's top face, and an electrical conducting material of the same kind, and including the cylindrical shape-like 2nd bump mostly.
[Claim 2] Bump structure according to claim 1 characterized by the configurations of the 1st bump and the 2nd bump being almost the same.
[Claim 3] Bump structure according to claim 1 where the 2nd bump's configuration is characterized by reducing the 1st bump's configuration.
[Claim 4] Claims 1 and 2 characterized by the 1st bump and the 2nd bump being gold and the alloy of palladium, and bump structure given in three.
[Claim 5] The capillary for bump manufacture characterized by processing vertically the hole to which the wire which consisted of a flat side where a head is smooth, and was prepared at the head is led, and the edge constituted by said flat side sharp.

[Claim 6] The process which forms a metal ball at the head of the wire which it let pass to the capillary for bump manufacture, The process which fixes the 1st bump's pars basilaris ossis occipitalis which impressed the supersonic wave and was mostly formed in the shape of a cylinder to said electrode, pressing said metal ball at the head of said capillary for bump manufacture to an electrode, The head of said capillary for bump manufacture is detached from said 1st bump to the degree of this process. A supersonic wave is impressed. since, turning said capillary for bump manufacture to said 1st bump again, and pressing [make the flat side around the hole to which it is made to move to a longitudinal direction and said wire at the head of said capillary for bump manufacture is led correspond to said 1st bump's core,] it since -- the bump manufacture approach characterized by including the process which pulls apart said capillary for bump manufacture from said 1st bump, and cuts said wire from said 1st bump, and the process which forms the 2nd bump like said 1st bump on said 1st bump.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the bump for mounting, the capillary for bump manufacture, and the bump manufacture approach of a semiconductor device of a detailed electrode pitch especially about the capillary and the bump manufacture approach for manufacturing the bump for semiconductor device mounting, and a bump.

[0002]

[Description of the Prior Art] Drawing 5 is the sectional view showing the conventional bump manufacture approach in order of a process. The bump by this approach used the wirebonding technique, is the projection structure which formed the bonding wire in the point of the Au ball 24 in the shape of a loop formation, and has called the stud bump 26 (it indicates to Matsushita Electric Industrial Co., Ltd. issuance National Technical Report Vol.39 No.2 Apr.1993). As shown in drawing 5 (a), the Au ball 24 is formed at the head of a bonding wire 21 by a discharge spark etc. Next, as the thermocompression bonding of ultrasonic concomitant use shows the Au ball 24 to drawing 5 (b) using the capillary 22 used for wirebonding, it fixes to the aluminum electrode 3 of a semiconductor device 1, and the stud bump's 26 pars basilaris ossis occipitalis is formed. Subsequently, as are shown in drawing 5 (c), and draw the loop-formation-like orbit 25, a capillary 22 is moved, a wire loop formation is formed and it is shown in drawing 5 (d), a capillary 22 is dropped, second bonding of the bonding wire 21 is carried out to the top face of the stud bump's 26 pars basilaris ossis occipitalis, a wire 21 is torn off, and the stud bump's 26 point is formed in the top face of a pars basilaris ossis occipitalis.

Subsequently, leveling is performed by pressing the stud bump 26 who formed in respect of flat for flattening of the stud bump's 26 top face, and equalization of height. Thrust is about 50g / bump. The flip chip mounting structure using an above-mentioned stud bump is shown in drawing 6 . The stud bump 26 who formed in the aluminum electrode 3 of a semiconductor device 1 is connected to the substrate electrode 34 through conductive resin 31, and a semiconductor device 1 is made a face down and carried in the wiring substrate 32. The gap of the end-half conductive element 1 which stiffened conductive resin 31, and the wiring substrate 32 is made to pour in and harden closure resin 33.

[0003] Drawing 7 is the sectional view showing the conventional bump manufacture approach of a publication in JP,4-41519,B in order of a process. The part of the wire 21 close to a ball 24 serves as the coarse-grain-like crystal structure with recrystallization, and an ingredient which carries out embrittlement is used for the . (drawing 7 (a)) wire 21 which forms a bonding wire 21 in the capillary 22 for wirebonding, and forms a ball 24 at through and wire 21 head. The aluminum electrode 3 is made to fix this at the same time it pushes a ball 24 against the aluminum electrode 3 on a semiconductor device 1 by the capillary 22 and forms a bump 27 (drawing 7 (b)). Next, tensile force is applied and a wire 21 is cut, after giving a notch 28 to the part in which moved the capillary to above and a longitudinal direction, and the wire 21 carried out embrittlement in respect of the soffit of a capillary 22 (drawing 7 (c), (d)).

[0004] Drawing 8 is the conventional bump manufacture approach indicated by JP,3-187228,A using a ball bonding technique. The wire which consists of Au, Cu, or a Cu alloy to up to the aluminum electrode 3 of a semiconductor device 1 is inserted in a capillary. It is made to join to heating with a supersonic wave, making a ball form at the head and pushing on the aluminum electrode 3. . (drawing 8 (a)) which pulls a wire upwards, cuts it and forms the undershirt bump 34 -- subsequently pass the same process as the above-mentioned with a solder wire to up to the undershirt bump 34 -- the pewter bump 35 is formed (drawing 8 (b)). In order for the solder ball formed at the head of a capillary at this time to carry out melting of the solder part by the final process (drawing 8 (c)) and to make it into the shape of a semi-sphere on the aluminum electrode 3, it is larger than the above-mentioned undershirt bump 34.

[0005] Drawing 9 (a) and (b) are the front view of a capillary 22 used for the conventional wirebonding, respectively, and the expanded sectional view of a point. In the capillary for these wirebonding, the taper rolling of the edge 30 of the hole at the head of a capillary 22 is carried out so that a blemish may not be attached to a wire (or R processing which attaches a radius of circle is carried out). Using the capillary 22 of the same configuration as drawing 9 also by the conventional bump manufacture approach which also shows the conventional bump manufacture approach shown in drawing 5 in drawing 7 , the capillary to which a taper rolling or R processing was carried out is used for the edge of the hole at a head.

[0006]

[Problem(s) to be Solved by the Invention] When the conventional bump manufacture approach shown in drawing 5 forms a wire loop formation, since the wire 21 is thinner than the bore of the hole at the head of a capillary 22, a wire 21 slackens during capillary actuation, it is generated, and uniform loop shape is not acquired. Moreover, according to the location precision of bonding equipment, dispersion arises in the sense of a loop formation. And leveling for making height into homogeneity had the fault that the deformation of a bump's longitudinal direction was large.

[0007] The conventional bump manufacture approach shown in drawing 7 is limited to the ingredient with which the ingredient used for a wire 21 forms the coarse-grain-like crystal structure. Since a bump is crushed by pressurizing in order to form a notch 28 in the fragile site of a wire furthermore, there is a fault that bump height becomes low. Furthermore, if micrifying of an electrode pitch progresses, the diameter of a bump also has the fault that become small and bump height becomes low. There is a fault that inflow of closure resin is bad in the gap of a semiconductor device and a wiring substrate in the closure process by the resin at the time of flip chip mounting when a bump's height is low, and air bubbles remain.

[0008] By the conventional bump manufacture approach shown in drawing 8 , the wire which forms an undershirt bump, and the wire which forms a solder bump are separate, and a process becomes complicated. Moreover, the heights which the cutting location of the wire when pulling up a capillary and cutting a wire after forming the undershirt bump 34 is not stabilized, but are formed in the undershirt bump's 34 center section becoming high, and joining the solder bump 35 on the undershirt bump 34 in such a case carries out in difficulty, it is, and is very **. Moreover, even if a gap arises in the location of the capillary at the time of formation of the undershirt bump 34 and the solder bump 35, it comes to spread difficulty or becoming and joining [to spread] the solder bump 35 also according to the undershirt bump's 34 construction material in difficulty. Moreover, there is a fault in which the property of solder material deteriorates by the reaction of solder and an undershirt bump in the final process of drawing 8 (c).

[0009] Moreover, by the above-mentioned conventional bump manufacture approach, since a taper rolling or R processing is performed to the edge of the hole at the head of this capillary using the capillary for wirebonding as each shows to drawing 9 , there is a fault that the location where a wire is cut varies.

[0010]

[Means for Solving the Problem] The bump structure of this invention consisted of the 1st bump who consists of the electrical conducting material which the base fixed, and which is a cylindrical shape-like mostly on an electrode, the 1st bump whom the base fixed on this 1st bump's top face, and an electrical conducting material of the same kind, and is mostly equipped with the cylindrical shape-like 2nd bump.

[0011] The capillary for bump manufacture of this invention is characterized by

processing vertically the hole to which the wire which consisted of a flat side where a head is smooth, and was prepared at the head is led, and the edge constituted by said flat side sharp.

[0012] The process which forms a metal ball at the head of the wire which let the bump manufacture approach of this invention pass to the capillary for bump manufacture, The process which fixes the 1st bump's pars basilaris ossis occipitalis which impressed the supersonic wave and was mostly formed in the shape of a cylinder to said electrode, pressing said metal ball at the head of said capillary for bump manufacture to an electrode, The head of said capillary for bump manufacture is detached from said 1st bump to the degree of this process. A supersonic wave is impressed. since, turning said capillary for bump manufacture to said 1st bump again, and pressing [make the flat side around the hole to which it is made to move to a longitudinal direction and said wire at the head of said capillary for bump manufacture is led correspond to said 1st bump's core,] it since -- it has the process which pulls apart said capillary for bump manufacture from said 1st bump, and cuts said wire from said 1st bump, and the process which forms the 2nd bump like said 1st bump on said 1st bump.

[0013]

[Example] Next, this invention is explained to a detail with reference to a drawing.

[0014] Drawing 1 is the sectional view of the bump structure of the 1st example of this invention. The bump who shows drawing 1 consists of the 2nd aluminum/Pd bump 5 who is formed on the aluminum electrode 3 on a semiconductor device 1, and has a field parallel to the aluminum electrode 3 in the upper part and who is mostly formed in the center section of the level surface of the upper part of the 1st cylindrical shape-like Au/Pd bump 4 and the 1st Au/Pd bump 4, and has the cylindrical heights 6 on the upside level surface by the shape of isomorphism mostly with the 1st Au/Pd bump 4. In addition, the protective coat 2 is formed in front faces other than aluminum electrode 3 of a semiconductor device 1.

[0015] When the electrode pitch of a semiconductor device 1 is 120 micrometers, the 1st Au/Pd bump's 4 diameter sets 80 micrometers and height to 35 micrometers, the 2nd Au/Pd bump's 5 configuration is almost equal to the 1st Au/Pd bump 4, and the heights 6 of the cylinder in the upside level surface are taken as the diameter of 40 micrometers, and height of 15 micrometers. These configurations can adjust about **5-10 micrometers according to a bump's construction material and the bonding conditions when forming. In addition, the 1st and 2nd bumps' ingredient is not restricted to the alloy of gold and palladium, but the alloy metallurgy of gold and tin can also be used for it.

[0016] Drawing 2 is the sectional view of the bump structure of the 2nd example of this invention. the bump who shows drawing 2 is formed on the aluminum electrode 3 on a semiconductor device 1, and has a field parallel to the aluminum electrode 3 in the upper part -- with the 1st cylindrical shape-like Au/Pd bump 4 mostly Small

configurations which were formed in the center section of the level surface the 1st Au/Pd bump's 4 upper part, and were reduced at least 10% or more from the 1st Au/Pd bump 4 are consisted of by the 2nd Au/Pd bump 5 who has the cylindrical heights 6 on a top-horizontal-discharge side.

[0017] When the electrode pitch of a semiconductor device is 120 micrometers, the 1st Au/Pd bump's 4 diameter sets 80 micrometers and height to 35 micrometers, and the heights 6 of the cylinder which the 2nd Au/Pd bump's 5 diameter has in 60 micrometers, and height has in the level surface of 25 micrometers and the upper part are taken as the diameter of 40 micrometers, and height of 10 micrometers. These configurations can adjust about **5-10 micrometers according to a bump's construction material and the bonding conditions when forming.

[0018] Drawing 3 is the sectional view of one example of the capillary for bump manufacture of this invention. An apical surface 9 is processed evenly and the hole 11 to which a wire is led, and the edge 10 constituted by the apical surface are processed sharp vertically. When forming a bump using a wire with a diameter of 25 micrometers, 33 micrometers of an aperture are the optimal.

[0019] Drawing 4 is the sectional view showing the process which forms the two-step bump of the example shown in drawing 1 . When an electrode pitch forms the two-step bump 7 in the aluminum electrode 3 which is 120 micrometers, the Au/Pd ball 13 is formed in the capillary 8 for bump manufacture shown in drawing 3 with a head bore diameter of 33 micrometers using the Au/Pd bonding wire 12 with a diameter of 25 micrometers at the head of through and the capillary 8 for bump manufacture. (Drawing 4 (a)) . Subsequently, making the Au/Pd ball 13 press and transform by 50g of loads, after uniting the location of the capillary 8 for BOMPU manufacture with the aluminum electrode 3 of a semiconductor device 1 currently heated by 200 degrees C on the heating stage, a supersonic wave is used together, it joins to the aluminum electrode 3, and the 1st Au/Pd bump 4 is formed (drawing 4 (b)). Then, while raising the capillary 8 for bump manufacture by 110 micrometers, 35 micrometers of capillaries 8 for bump manufacture are moved to a longitudinal direction so that it may be located corresponding to the core of the 1st Au/Pd bump 4 which the flat part at the head of the capillary 8 for bump manufacture joined (drawing 4 (c)). After migration is completed, the capillary 8 for bump manufacture is descended, and a supersonic wave is impressed, while pressing again towards the 1st Au/Pd bump so that only the Au/Pd bonding wire 12 may transform the flat-surface section 9 at the head of the capillary 8 for bump manufacture with the Au/Pd bonding wire 12 (drawing 4 (d)). As for the Au/Pd wire 12, a notch 28 is formed of the edge section 10 of the bore of the capillary 8 for bump manufacture by migration of this longitudinal direction, and the effectiveness of a supersonic wave. In this condition, the notch 28 in which the Au/Pd bonding wire 12 was formed of the sharp edge section 10 of the capillary 8 for bump manufacture serves as a configuration fractured easily. If the capillary 8 for bump manufacture returns to a

zero, the Au/Pd bonding wire 12 will fracture and the 1st Au/Pd bump 4 will be formed on the aluminum electrode 3 of a semiconductor device 1.

[0020] Subsequently, on the 1st Au/Pd bump 4, alignment is carried out and the 2nd Au/Pd bump 5 is formed (drawing 4 (e) - (i)). Bonding can be carried out like [the 2nd Au/Pd bump 4] the 1st Au/Pd bump 4. However, since bonding conditions become junction with the 1st Au/Pd bump 4, a load and a supersonic wave can be pressed down low and there are no damages (generating of a crack etc.) of a semiconductor device 1.

[0021] Although manufacture of the bump of the example shown in drawing 2 is the same as that of an above-mentioned approach, when forming the 2nd bump 5 compared with the 1st bump 4, the conditions of the discharge spark at the time of ball formation at the head of a wire 12 are set up so that the Au/Pd ball 13 may become small. By making the 2nd bump 5 smaller than the 1st bump 4 like drawing 2 , dispersion in the location of a capillary with the time of the 1st bump's 4 formation and the 2nd bump's 5 formation is absorbed, and the 2nd bump 5 can be certainly formed on the 1st bump 4. Moreover, since the 2nd bump 5 by the side of a bump head is thin when this bump is joined by solder to the substrate electrode of the other party, it has been got wet so that solder may cover all the 2nd bump's 5 front faces, and is effective in the soldered joint to a substrate electrode being ensured. Moreover, the bump of this invention can prepare in the electrode on a ceramic substrate etc. instead of the electrode on a semiconductor device.

[0022]

[Effect of the Invention] Since the bump structure of this invention has taken two-step structure, it can form a bump higher than the conventional bump. Moreover, in order not to form a wire loop formation, complicated actuation of a capillary is not needed.

[0023] Moreover, since the capillary for bump manufacture of this invention is the sharp structure where the edge at the head of the hole which lets a wire pass was processed vertically, by using a supersonic wave together and cutting the wire and the bump, it is stabilized and can form a highly precise bump without dispersion in height. Moreover, since height can control to high degree of accuracy and a leveling process is not needed, it is based on crushing by the longitudinal direction, and varies, and a bump can be formed that there is nothing.

[0024] Moreover, the bump structure of this invention has the good junction nature of the 1st bump and the 2nd bump, in a process's becoming simple, since the 1st bump and the 2nd bump are formed from the ingredient of the same kind. Since height is enabled to make it high compared with the former and the semiconductor device when carrying out flip chip mounting and the gap of a wiring substrate become large, a bump's casting nature of closure resin improves. The joint of the bump who put on two more steps has the effectiveness which prevents concentration of stress to destruction by the coefficient-of-thermal-expansion difference of a semiconductor device and a substrate. Moreover, it is not necessary to use special wire material which gives the part of the

brittle coarse-grain-like crystal structure with recrystallization to the wire near [which was formed at the head of a wire] the ball.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing the 1st example of the bump structure of this invention.

[Drawing 2] It is the sectional view showing the 2nd example of the bump structure of this invention.

[Drawing 3] It is drawing showing one example of KYAPURARI for bump manufacture of this invention, and (a) is a front view and (b) is the expanded sectional view of a point.

[Drawing 4] It is the sectional view showing a bump's manufacture approach shown in drawing 1 in order of a process.

[Drawing 5] It is the sectional view showing the conventional bump manufacture approach in order of a process.

[Drawing 6] It is the sectional view showing the flip chip mounting structure which used the bump manufactured by the approach of drawing 5 .

[Drawing 7] It is the sectional view showing other conventional bump manufacture approaches in order of a process.

[Drawing 8] It is the sectional view showing the conventional bump manufacture approach of further others in order of a process.

[Drawing 9] (a) And (b) is the front view of the conventional capillary, and the sectional view of a point, respectively.

[Description of Notations]

1 Semiconductor Device
2 Protective Coat
3 Aluminum Electrode
4 1st Bump
5 2nd Bump
6 Cylindrical Heights
7 Two-Step Bump
8 Capillary for Bump Manufacture
9 Apical Surface
10 Edge Section
11 Hole
12 Au/Pd Wire

13 Au/Pd Ball
21 Bonding Wire
22 Capillary
24 Au Ball
25 Loop-Formation-like Orbit
26 Stud Bump
27 Projection Contact Surface
28 Notch
30 Edge
31 Conductive Resin
32 Wiring Substrate
33 Closure Resin
34 Undershirt Bump
35 Solder Bump